

1B. Risk assessment and management

The use of ammonium nitrate-based explosives and organic boosters leads to emissions of ammonium, nitrate, nitrite and nitroorganic compounds to the environment. From the application of construction chemicals (sprayed concrete, retarders, slurries, hydraulic liquids, etc.), contaminants such as hexavalent chromium, aluminium, and various organic chemicals including biocides are released to the environment.

These compounds lead to negative effects in susceptible surface waters and used groundwater. Observed effects are general ecotoxicity to aquatic life, fish toxicity (nitrite, ammonia, Al^{3+}), eutrophication (nitrate), inhibition of photosynthesis (turbidity) or oxygen depletion (by dissolved organic carbon).

The emission of the substances occurs via multiple pathways: Polluted excavated material is often deposited in or along surface waters because of space shortage in the project area. From there, contaminants and fine materials are released into the water during and after the deposition. A second important emission path are tunnel effluents that are discharged to creeks with partly low runoffs. Additionally, highly contaminated material such as sludges from material recycling are deposited in project-specific landfills in the project perimeter which can lead to additional emissions.

The flux of pollutants to protective goods and therefore the environmental risk is highly variable in time and location and depends on the construction activities at the multiple construction sites as well as the environmental conditions such as seasonal variability of precipitation (snow, rain), hydraulic discharges of rivers, water levels of lakes etc. To overcome these complexities, we have established a unique method for the identification of possible environmental hazards during the entire construction works. This method is based on a holistic analysis of all project phases and processes. The project system is represented by a mathematical model that predicts contaminant fluxes and concentrations as a function of time and space in all protective goods of concern. The predicted environmental concentrations (PEC) are compared to (eco)toxicologically based reference levels (predicted no effect concentration, PNEC). This risk assessment method has already successfully been applied in several Swiss projects.

The benefit of this upfront environmental risk assessment is to anticipate possible hazards already in the planning phase of the project as an integral part of the environmental impact assessment. The risk assessment allows the identification and prioritization of the relevant processes, time points and locations, which potentially lead to critical environmental impacts. These procedure guarantees the implementation of risk reduction measures and hence investments at locations with the highest impact. Such measures include installations (such as water treatment plants), application of best-practices (e.g. for the application of emulsion explosives) or the use of environmentally friendly products.

The presentation will give an overview on the method that allows for the holistic assessment of all contaminant emissions at all construction sites during the entire construction project. The strengths and limitation will be discussed as well as illustrative results from reference projects will be presented. The substances of concern, their sources and possible effects will be addressed.

ARSENIC, ANTIMONY AND SELENIUM IN URBAN SOILS: POTENTIAL RISKS FOR HUMAN HEALTH IN URBAN GARDENING

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The benefits of urban agriculture are many and well documented, ranging from health improvement to community betterment, more sustainable urban development and environment protection. On the negative side, urban soils are commonly enriched in toxic trace elements that have accumulated over time through the deposition of atmospheric particles (generated by automotive traffic, heating systems, historical industrial activities and resuspended street dust), and the uncontrolled disposal of domestic, commercial and industrial wastes. This in turn has given rise to concerns about the level of exposure of urban farmers to these elements and the potential health hazards associated with this exposure. Research efforts in this field have started relatively recently and have almost systematically omitted the influence of Sb and Se, and to a lesser extent of As, although all three have proven toxic effects.

In this study, the concentrations of aqua regia-extractable As, Sb and Se have been determined by GF-AAS in 42 soil samples collected with an Edelman auger from the upper 20 cm of the soil profile in seven urban gardens in Madrid. Soil physicochemical properties, i.e. soil pH, texture, calcium carbonate and organic matter contents have also been evaluated. Frequency and duration of exposure, and rates of consumption of vegetables grown in the selected urban gardens have been estimated from the results of an on-site survey. The mean concentration of As in the seven urban gardens is similar to regional background levels but the average content of Sb and Se are one order of magnitude higher, and in the case of Sb, exceeds the guideline value for agricultural land use in Madrid.

The risk for urban farmers from exposure to As, Sb and Se through four routes of exposure (accidental ingestion of soil, inhalation of suspended particles, dermal absorption and ingestion of vegetables) has been assessed. The quantitative results of the risk assessment are very sensitive to changes in the value assigned to two key variables that are affected by a high degree of uncertainty: soil ingestion rate and soil-to-plant uptake factor. For the values used in our model, taken from the USEPA's Soil Screening Guidance and from the RAIS database, the highest contribution to the overall risk is associated with the accidental ingestion of soil particles, followed by ingestion of on-site grown vegetables and dermal absorption (inhalation of suspended particles has a negligible influence). However, changes in the soil-to-plant uptake factor within the range of published values for this variable can result in a contribution of ingestion of vegetables higher than that of soil ingestion, and in a different value of the predicted overall risk. It remains unaffected the fact that As is the contaminant of most concern given its carcinogenic nature. In terms of systemic toxicity, As is also the main contributor to the aggregate Hazard Index, followed by Sb and Se.

The estimates of overall systemic risk are more than one order of magnitude lower than the threshold values of $\text{HI}=1$, but that of carcinogenic risk, associated with the exposure to As, lies in the range of 10^{-5} - 10^{-6} , close or even above the limit of acceptability, depending on national environmental regulations. Although risk assessments make use of very conservative assumptions, these results indicate the need for further research in order to reduce the uncertainty in some of the variables included in the model and to dissipate the concerns regarding the potential for adverse health effects associated with the practice of urban gardening.